Why is the ocean running out of fish?

A **commons** = a resource anyone may use, where each user leaves less for the others (the open sea, a free road, a village pasture). Each user keeps the gain of taking more and shares the loss → it is used until little is left. Lesson 1's trap with many players, where nobody can watch or punish. Three ways out, each with a cost; the lesson gives no verdict.

1 The lake

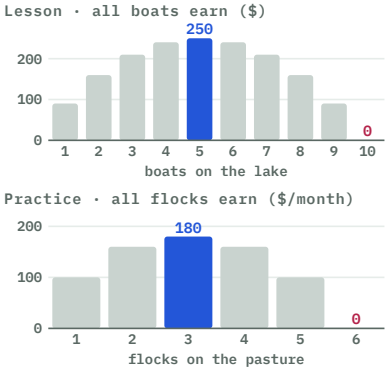
one more boat

- **Your move**: 5 boats fish a lake, send a 6th? (never graded or stored)
- Toy (made-up) numbers: n boats → each catches `120 − 10n` fish · fish $1 · boat $20 a season ⇒ each earns `100 − 10n` · all `n(100 − 10n)`
- 1 boat 90 · 2 → 80 each, 160 · 4 → 60 each, **240** · 5 → 50 each, **250**
- 6th boat: earns **+40** for its owner · the 5 others 50 → 40: **−50** · the lake **−10** (250 → 240) ⇒ the owner still sends it (40 > 0 at home)
- **Externality**: "a cost or benefit that falls on people who did not choose it" (Micro 10)
- Practice · pasture, each flock (group of sheep) `120 − 20n`: 3 flocks 60 each, 180 · 4th flock **+40**, the other three lose `3 × 20 = 60` → pasture **−20** (180 → 160)

2 Best vs open

the tragedy

- Best for the lake: tallest bar → **5 boats, $250** (4 or 6: 240)
- Open to all: a boat joins while it does not lose money → 6th +40 … 9th +10 · 10th 0 → **10 boats, each $0, lake $0**
- **Tragedy of the commons**: each user keeps the gain, all share the loss → overused · **Garrett Hardin**, American ecologist, article 1968
- Practice: best **3 flocks, $180** · open access ends at **6 flocks, $0** (5th still earns 20) · **open access** = anyone may use → users come until one more earns nothing



3 Many players

Lesson 1, × 1000

- Take more = **best reply** (the move that pays most) for each user while it does not lose money · all take more ⇒ all worse off = prisoner's dilemma with many players
- Lesson 5's exit (**tit-for-tat**: cooperate first, then copy the other's last move) needs players who meet again, see a cheat, punish it
- Open sea: ≈ 1000 boats, 20 countries → one boat = a tiny part of the harm → cheat **hard to see**, nobody can **punish** one boat in a thousand
- Practice: pump a lot **dominant** (7 > 5, 4 > 3) → **4 / 4** though 5 / 5 better for both · 2 farms who meet yearly and see the pump → tit-for-tat can hold 5 / 5

PRACTICE · TWO FARMS, ONE RIVER · $100S/MONTH

	Ben little	Ben a lot
Ana little	5 / 5	3 / 7
Ana a lot	7 / 3	4 / 4

4 The real sea

and other commons

- **FAO** (Food and Agriculture Organization of the United Nations), report **2026**: ≈ **38%** of fish stocks (one kind of fish in one area) fished beyond a sustainable level = faster than they grow back (a bit more than ⅓, growing over decades)
- Same game: free road → jams (each driver ignores the delay added) · antibiotics (medicines vs germs) → lose power · climate → each country emits more greenhouse gas
- Commons? ask: anyone may use it? each user leaves less? ✓ pasture, free road, café Wi-Fi, free parking, forest berries · × cinema seat with ticket, fenced field, own data plan (an owner) · street light (nothing used up)

5 Three ways out

each has a cost · no verdict

- ① **Government limit**: **quota** ("a limit on how much may be taken, by all users or by each one") or fee · for: one rule binds every boat · cost: measure + police; boats race to fish before the total cap
- Practice fee $50 a flock → keeps `70 − 20n` · 3 flocks +10 · 4th −10 → stays home ⇒ **3 flocks** · fees `3 × 50 = 150` + kept `3 × 10 = 30` = **180** (how it works, not whether it is best)
- ② **Property rights**: **individual transferable quota** = tradable (sellable) share of the yearly catch, owned like a house · New Zealand **1986** · Iceland from **1984**, all fisheries **1990** · for: a healthy stock makes the share worth more · cost: a few big owners may hold most shares
- ③ **Rules the users write**: **Elinor Ostrom**, American political scientist, Nobel economics **2009** · Swiss mountain pastures, lobster fishers in Maine (US), canal water in Spain · clear boundaries · rules made with users · members watch each other · penalties that grow with each offense · for: they know the place · cost: best in small, close groups

Watch out: best for the user ≠ best for the lake (5 boats vs 10) · the tragedy needs **no bad people**: each boat's move is a best reply · "free" ≠ commons: it must also get **used up** · the three ways out each have a cost: no rule is "the right one"